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(56) Documents Cited
GB 2079877 A **GB 2078318 A**
US 6019698 A **US 5771477 A**
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(54) Abstract Title
Transmission synchroniser

(57) A gearbox has an input shaft 12 with three input gears 16,18,20, the first two fixed to the shaft, the third mounted for relative rotation, an output shaft 22 with three output gears 26,28,30, the first two mounted for relative rotation and meshing with input gears 16,18 respectively, the third being fixed to the output shaft 22 and meshed with input gear 20. The output shaft 22 has a clutch mechanism 38 to clutch the first output gear 26 to the output shaft 22, and also has a brake mechanism 42 which acts on the first output gear 26. The gearbox also has two sensors 44,46 to detect rotational speed of the input 12 and output 22 shafts respectively. The clutch 38 and brake 42 mechanisms are used to adjust the rotational speed of the shafts 12,22 so they match the required rotational speeds for a change in gear. In an alternative arrangement, the brake 42 may be replaced by a pump 60 which works in a manner to provide a counter-torque to reduce shaft rotation speed.

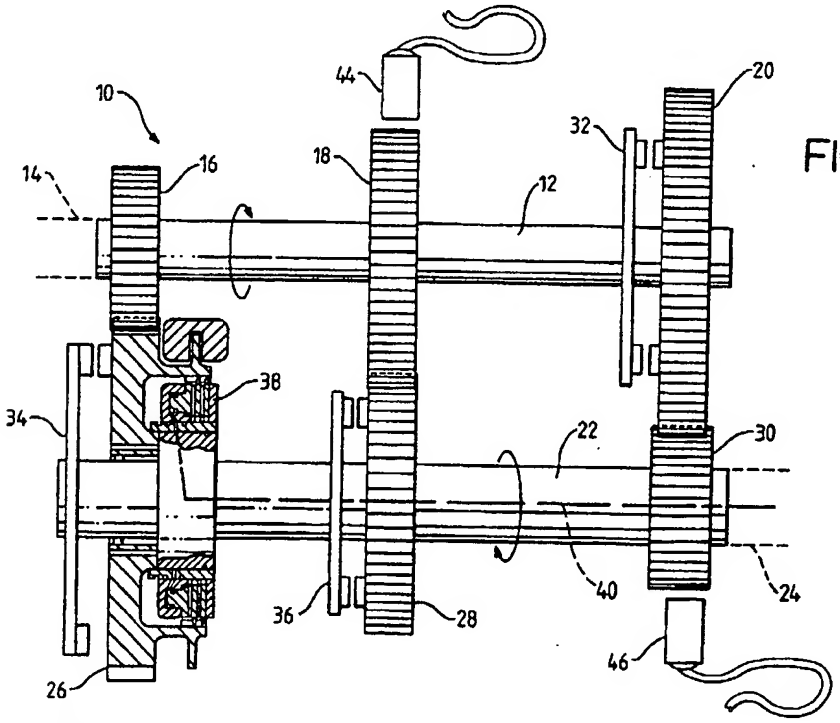

FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

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FIG. 1

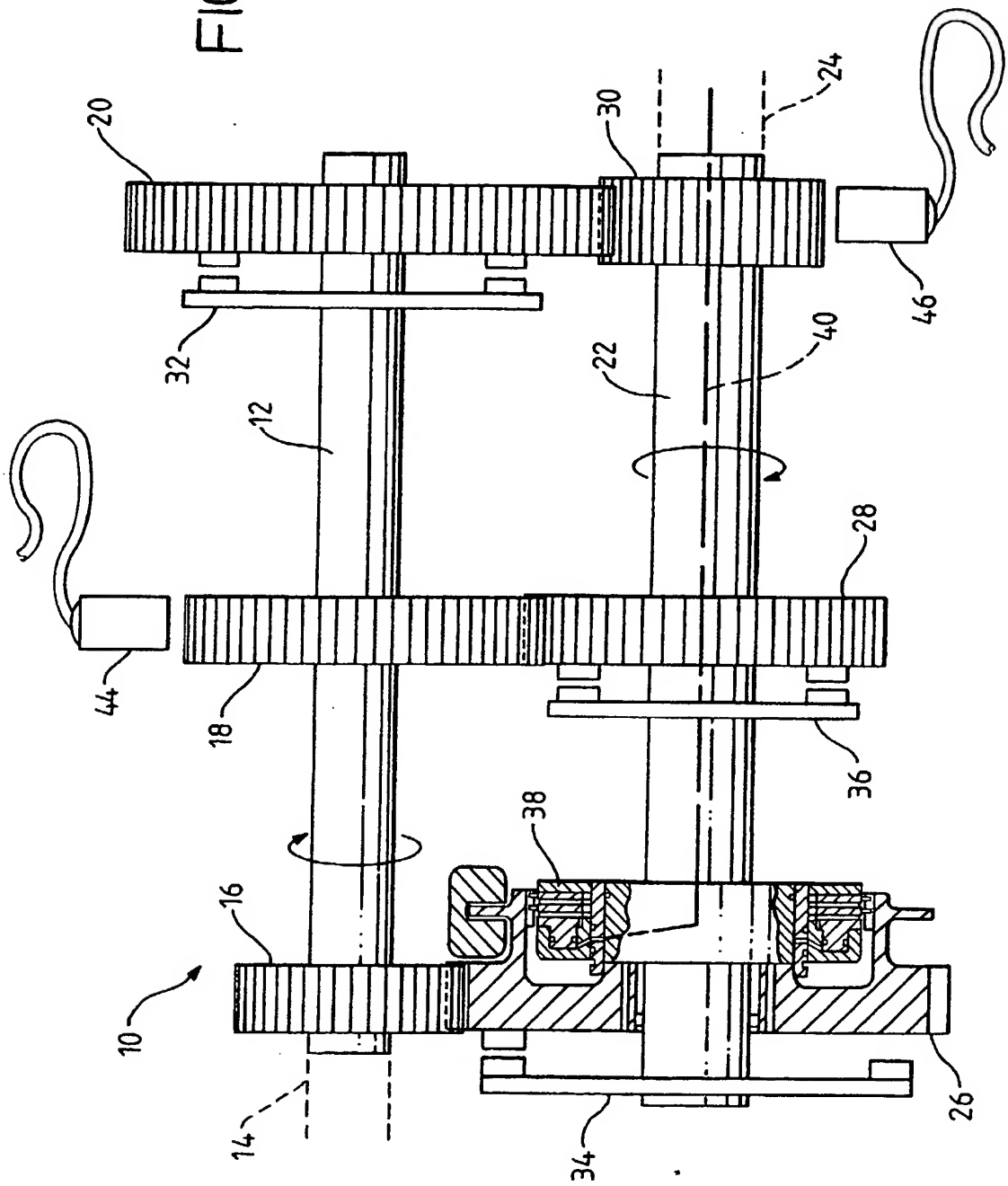
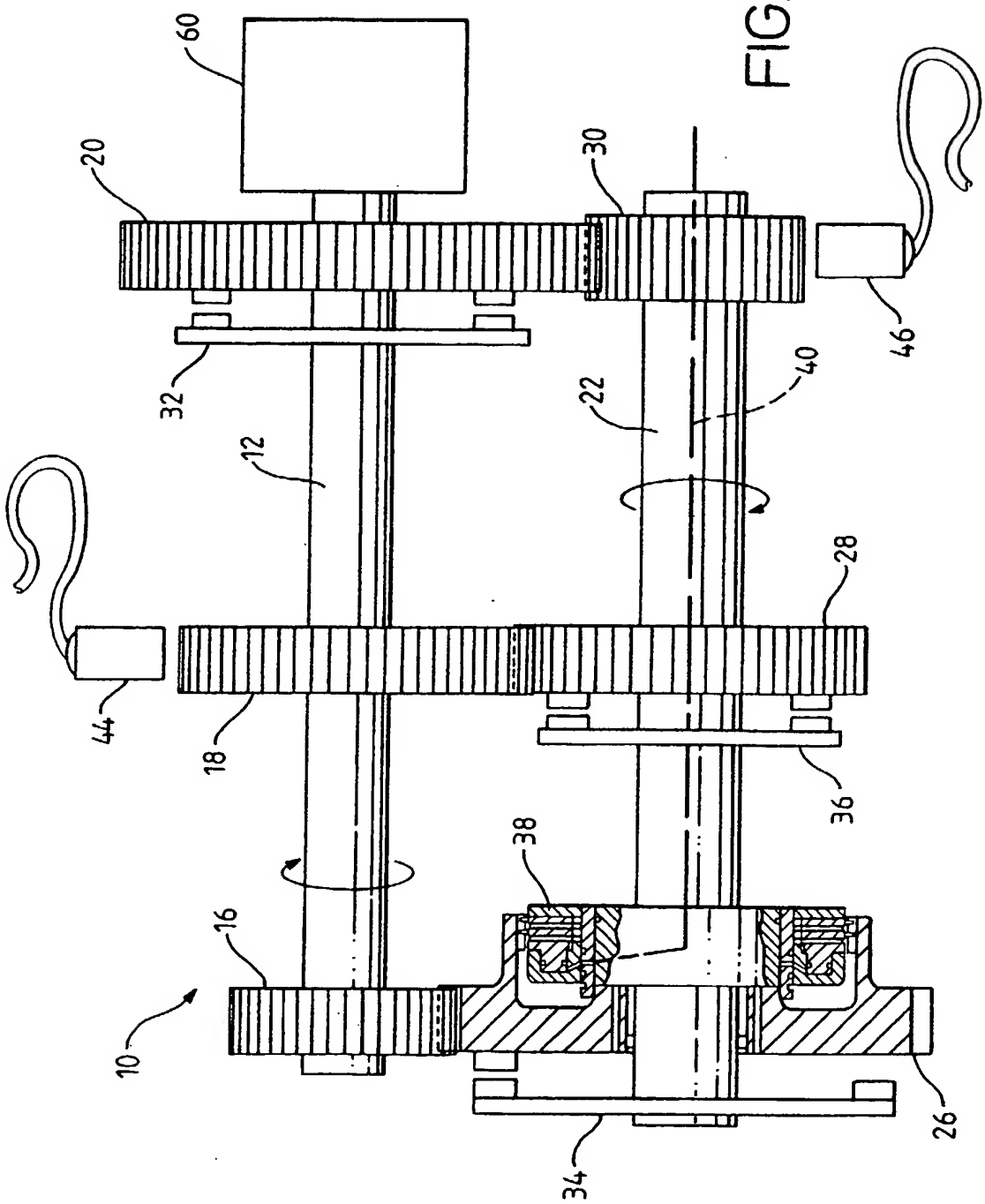


FIG. 2



Transmission Synchroniser

The present invention relates to a transmission synchroniser and particularly, but not exclusively, to an apparatus for synchronising the rotational speeds of an input shaft and an output shaft in a gearbox or other transmission mechanism.

Before a gear change can take place within, for example, a vehicle gear box, it is necessary to synchronise the rotational speeds of the transmission elements being joined. Synchromesh mechanisms have previously been employed interposed between the main gears in the gearbox. A disadvantage is that such a mechanism is required for each gear set in the gearbox.

The present invention seeks to provide an improved transmission synchroniser.

According to one aspect of the present invention, there is provided a mechanism for synchronising the rotational speeds of shafts in a gearbox, the gearbox including an input shaft and an output shaft, said shafts having at least one gear pair mounted thereon, and synchronising means interposed between the shafts and including a fixed gear which is fixedly mounted on one shaft and a rotatable gear which is selectively rotatable about the other shaft, said fixed and rotatable gears being meshed with one another, and clutch means for selectively clutching said rotatable gear to its respective shaft to alter the rotational speed of said rotatable gear to approach that of its shaft, thereby to alter the rotational speed of the other shaft through said fixed gear whereby to permit said shafts to be drivingly engaged to one another through said gear pair.

Conveniently, the fixed gear may be mounted on the input shaft and the rotatable gear may be mounted on the output shaft, the fixed and rotatable gears together constituting a first gear set of said gearbox. Preferably, the ratio of said fixed gear to said rotatable gear is in the region of 10:1.

Advantageously, the mechanism may also include braking means for selectively braking said rotatable gear thereby to decrease the rotational speed of the fixed gear and the input shaft. Alternatively, the mechanism may include braking means for selectively braking said input shaft.

Sensor means may be included for sensing the rotational speeds of the input and output shafts to determine when the shafts are synchronised and gear engagement can be performed.

The present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic cross sectional diagram of a preferred form of synchronising mechanism according to the invention; and

Figure 2 is an alternative form of synchronising mechanism according to the invention.

Referring to Figure 1, a conventional vehicle gearbox incorporating a preferred form of synchronising mechanism according to the invention is shown generally at 10. Figure 1 is not, however, intended to represent the actual layout of a gearbox and is used merely to illustrate the principle of operation of the invention. It will become apparent, therefore, that the mechanism of the invention may be used in conjunction with any gearbox layout, having any number of gear sets, and is in no way limited to a gearbox having a layout in accordance with Figure 1.

The gearbox includes an input shaft 12 which is arranged to rotate about its axis. One end 14 of the input shaft 12 is coupled to the engine of the vehicle to be rotatably driven thereby. The shaft 12 is connected to the engine (not shown) through a main clutch mechanism (not shown) which allows the shaft to be selectively driven by the engine or to rotate freely within the gearbox.

The input shaft 12 has a plurality of gears mounted thereon. In Figure 1, the input shaft has

three input gears, a first input gear 16 and a second input gear 18, being fixedly mounted to the shaft for rotation therewith, and a third input gear 20 being mounted for relative rotation about the input shaft 12.

The gearbox also includes an output shaft 22 mounted for rotation about its axis. In Figure1, the output shaft 22 is shown disposed in parallel with the input shaft although in other gearboxes to which the present invention is applicable, the output shaft may be off-set or axially aligned with the input shaft. One end 24 of the shaft 22 is connected to the driven wheels of the vehicle in known manner, for example via a further drive train or a differential mechanism thereby to drive the wheels.

The output shaft 22 also has a plurality of gears mounted thereon. In Figure 1, the output shaft 22 has three output gears corresponding to the three input gears of the input shaft 12. The output shaft 22 has a first output gear 26 and a second output gear 28 rotatably mounted on the output shaft 22 for relative rotation about the axis of the shaft, the first output gear being radially aligned and meshing with the first input gear 16 and the second output gear 28 being radially aligned and meshing with the second input gear 18. A third output gear 30 is fixedly mounted to the output shaft 22 for rotation with the shaft, the third output gear being radially aligned and meshing with the third input gear 20.

The meshing pairs of gears, i.e. gears 16 and 26, gears 18 and 28 and gears 20 and 30 represent first, second and third gear sets respectively of the gearbox. The gearbox illustrated in Figure 1 is therefore a three speed gear box, although, as stated above the present invention is applicable to gear boxes having any number of gear sets. It can be seen that one gear in each gear set is free to rotate about the axis of its respective shaft relative thereto. Each such independently rotatable gear, in this case gears 20, 26 and 28 are arranged to be selectively engaged with the respective shaft by means of gear engagement mechanisms 32, 34 and 36 respectively. The gear engagement mechanisms are of a known type being fixedly mounted to the respective shaft adjacent the respective gear. It will be appreciated that in order for a gear to be successfully engaged without causing excess damage to the gear or the gear engagement mechanism, the gear must be rotating at substantially the same speed as its

adjacent gear engagement mechanism, i.e. at the same speed as the shaft on which it is mounted.

The output shaft 22 has a clutch mechanism 38 fixedly mounted thereto, axially adjacent the first output gear 26. The clutch is arranged selectively to clutch the first output gear 26 to the output shaft 22 upon application of a clutch control signal via signal line 40 from a control unit (not shown). The purpose of the clutch mechanism 38 is described below.

Also associated with the first output gear 26 is a brake mechanism 42 which is arranged selectively to act upon the first output gear 26 upon application of a brake signal from the control unit. Preferably the brake mechanism 42 is mounted in a fixed position relative to the shafts for example, mounted to the inside of a gearbox housing or casing. The purpose of the brake unit 42 is described below.

The gearbox 10 also includes one or more sensors 44, 46 arranged to detect the rotational speed of the input and output shafts respectively. In Figure 1 the sensors 44, 46 are arranged to sense the rotational speed of the second input gear 16 and the third output gear 46 respectively since these gears are fixedly mounted to their respective shafts and therefore always rotate at the rotational speed of the shaft.

Operation of the synchroniser mechanism of the present invention will now be described with reference to a gear change between gear sets 2 and 3 of the gear box of Figure 1. For illustrative purposes, the first gear set is assumed to have a drive ratio of 10:1 (i.e. 10 rotations of the first input gear 16 causes a single rotation of the first output wheel 26), the second gear set has a ratio of 5:1 and the third gear set has a ratio of 2:1. Again for illustrative purposes, it is assumed that the gear box is initially running with third gear engaged (i.e. gear engagement mechanism 32 in engagement with third input gear 20) with the input shaft rotating at a speed of 10,000 rpm.

Thus, the first, second and third input gears 16, 18, 20 rotate with the input shaft 12 at 10,000 rpm. The first and second output gears 26, 28, being meshed with the first and

second input gears 16, 18 respectively are free to rotate relative to the output shaft 22 and therefore rotate at 1,000 rpm and 2,000 rpm respectively.

The third output gear 30 meshing with the third input gear 20 and being driven thereby rotates at 5,000 rpm. Since the third output gear 30 is fixedly rotated to the output shaft 22, the output shaft therefore also rotates at 5,000 rpm.

When a downshift of gear is required, say from third gear to second gear, the drive from the engine is firstly disconnected from the input shaft 12 by operation of the main clutch (not shown). The input shaft 12 thus becomes driven only by the rotation of the output shaft 22 through the third gear set. Next, the gear engagement mechanism 32 is disengaged from the third input gear 20 such that the gear 20 is free to rotate relative to the input shaft 12 under the driving influence of the third output gear 30 and the input shaft 12 is free to rotate under its own inertia.

To enable a second gear to be successfully engaged, the second output gear 28 must be made to rotate at substantially the same speed as the gear engagement mechanism 36 and hence at the same speed as the output shaft 22. To achieve this, the sensor 46 detects the rotational speed of the output shaft which, immediately after disengagement of the clutch and gear engagement mechanism 32 is approximately 5,000 rpm (although this will begin to reduce as the vehicle, no longer being driven by the engine, begins to decelerate).

As the second output gear 28 is rotating at 2000 rpm under the influence of second input gear 18, it is necessary to increase its rotational speed to match that of the output shaft in order to ensure a smooth gear change. To achieve this, the clutch mechanism 38 is engaged such that the first output gear 26 is clutched to the output shaft 22 and begins to accelerate towards the rotational speed of the output shaft 22. This rotational acceleration causes the first input gear 16, meshing with the first output gear 26, also to accelerate, thereby accelerating the input shaft 12, the second input gear 18 and thus the second output gear 28.

The sensor 44 detects when the input shaft, and thus the second input gear reaches a speed

of around 25000 rpm. At this point, the second output gear, being driven by the second input gear, is rotating at around 5000 rpm, a speed approaching that of the output shaft. The clutch mechanism 38 is then disengaged to allow the first output gear and the input shaft to rotate freely and the second gear engagement mechanism 36 is actuated to engage the second output gear 28 with the output shaft 22.

The main clutch is then re-engaged to apply drive from the engine to the input shaft which is then transmitted to the output shaft via the second gear set.

An up-shift of gear ratio is achieved in a similar manner but by application of the brake mechanism 42. Assuming again that the input shaft is initially rotating at 10,000 rpm, the output shaft will be rotating at 2,000 rpm in second gear. For completeness, the first input gear 16 rotates at 10,000 rpm, the first output gear 26 rotates at 1,000 rpm, the third output gear 30 rotates at 2,000 rpm (since it is fixed to the output shaft 22) and the third input gear 20 rotates at 4,000 rpm.

To perform an up-shift, drive from the engine to the input shaft 12 is disengaged by the main clutch. The second gear engagement mechanism 26 is then disengaged. At this point, the output shaft 22 is rotating at 2,000 rpm (although this will begin to decrease as the vehicle decelerates) whilst the input shaft 22 is rotating under its own inertia at around 10,000 rpm.

In order to achieve a smooth engagement of third gear, the third input gear 20 must be made to rotate at substantially the same speed as the third gear engagement mechanism 32 and therefore at the same speed as the input shaft 12. To achieve this synchronising in speeds, the braking mechanism 42 is applied to the first output gear to reduce its rotational speed from 1,000 rpm to around 400 rpm. This, in turn reduces the rotational speed of the first input gear 16, and thus the input shaft 12 to around 4,000 rpm which is the rotational speed of the third input gear 20.

When the rotational speeds of the input shaft and the third input gear 20 are substantially identical as sensed by the sensors 44 and 46, the braking mechanism 42 is released, the third

gear engagement mechanism is actuated to engage the third input gear to the input shaft and the clutch is re-engaged to couple the input shaft to the engine.

An alternative form of the invention is illustrated in Figure 2 whereby the braking mechanism 42 is replaced by a pump mechanism 60. When a reduction in speed of the input shaft is required, for example on an up-shift, the pump mechanism 60 is actuated to provide a counter-torque to the input shaft thereby to reduce its rotational speed.

It will be appreciated that the present invention allows simple and effective synchronisation of the rotational elements in a gear box using a single synchronising mechanism. This, naturally reduces the cost, complexity and weight of a gearbox. It will also be appreciated that the present invention can be applied to gearboxes having any number of gear sets.

It should be noted that the values of rotational speed and gear ratios referred to above are used for illustrative purposes only and are not necessarily representative of actual values to be used.

Claims

1. A mechanism for synchronising the rotational speeds of shafts in a gearbox, the gearbox including an input shaft and an output shaft, said shafts having at least one gear pair mounted thereon, and synchronising means interposed between the shafts, including a fixed gear which is fixedly mounted on one shaft and a rotatable gear which is selectively rotatable about the other shaft, said fixed and rotatable gears being meshed with one another, and clutch means for selectively clutching said rotatable gear to its respective shaft to alter the rotational speed of said rotatable gear to approach that of its shaft, thereby to alter the rotational speed of the other shaft through said fixed gear whereby to permit said shafts to be drivingly the engaged to one another through said gear pair.

2. A mechanism according to claim wherein the fixed gear is mounted on the input shaft and the rotatable gear is mounted on the output shaft, the fixed and rotatable gears together constituting a first gear set of said gearbox.

3. A mechanism according to claim 1 or 2 wherein the ratio of said fixed gear to said rotatable gear is in the ratio of 10:1.

4. A mechanism according to any one of the proceeding claims comprising braking means for selectively braking said rotatable gear whereby to decrease the rotational speed of the fixed gear and the input shaft.

5. A mechanism according to any one of claims 1 - 3 comprising braking means for selectively braking said input shaft.

6. A mechanism according to any one of the preceding claims comprising sensor means for sensing the rotational speeds of the input and output shafts to determine when the shafts are synchronised and gear engagement can be performed.

7. A mechanism according to any one of the preceding claims comprising two or more gear pairs of different gear ratios selectively coupling the input and output shafts.

8. A mechanism according to any one of the preceding claims wherein the input shaft is drivingly connectable to a prime mover through clutch means.

9. A mechanism according to any one of the preceding claims comprising at least one fixed gear on the input shaft and at least one fixed gear on the output shaft each of said fixed gears meshing with a rotatable gear on the other shaft which gear is selectively rotatable about its respective shaft.

10. A mechanism according to any one of the preceding claims comprising clutch means for selectively clutching a rotatable gear to its associated shaft to accelerate the gear to the speed of the associated shaft, and braking means for selectively reducing the gear to the speed of the associated shaft.

INVESTOR IN PEOPLE

Application No: GB 0102335.7 10 **Examiner:** Joe Mitchell
Claims searched: 1-10 **Date of search:** 16 May 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F2D (DCA, DTG, DTR)

Int Cl (Ed.7): F16H 3/08, 3/083, 3/085, 61/04

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2079877 A	ROLLS-ROYCE MOTORS LIMITED	
A	GB 2078318 A	AUTOMOTIVE PRODUCTS LIMITED	
A	US 6019698	LAWRIE et al.	
A	US 5771477	SHOWALTER et al.	
A	US 5429005	FUKUI et al.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.